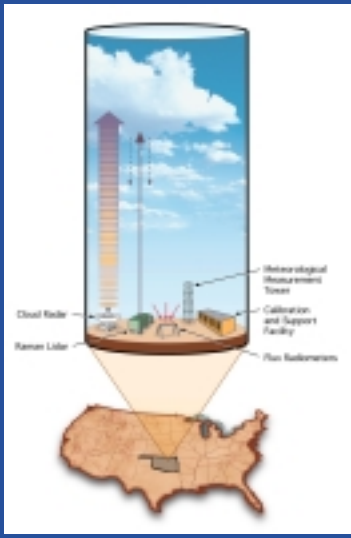
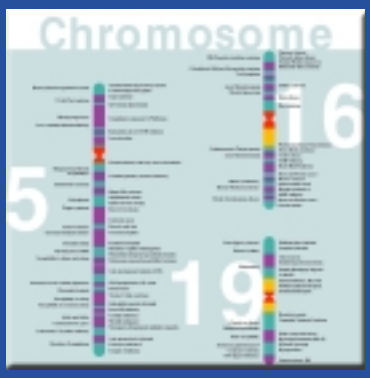
Office of Science

U.S. Department of Energy





Biological and Environmental Research

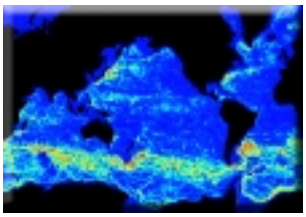
The Office of Science's Biological and Environmental Research (BER) program supports fundamental research in climate change, environmental remediation, genomics, proteomics, radiation biology, and medical sciences. In 2001, BER funded research at nearly 340 institutions, including colleges/universities, private industry, and Federal and private research institutions in 43 states and at 13 DOE laboratories in 9 states. BER supports leading-edge research facilities used by public and private sector scientists across a range of disciplines: structural biology, genome sequencing, functional genomics, climate science, the global carbon cycle, environmental molecular science, and medical imaging. BER works with other Federal agencies to coordinate research across all of these programs.

The Opportunity

With the 21st Century dawns what many have called the "biological century"—an era when advances in biology, spurred by achievements in genomic research, including the sequencing of the human genome, will bring revolutionary and unconventional solutions to some of our most pressing and expensive challenges in health, energy, the environment, and national security. We will understand how living organisms interact with and respond to their environments so well that we will be able to use biological processes to produce clean energy, remove excess carbon dioxide from the atmosphere, help clean up the environment, and better detect and defeat bioterrorism. Our understanding of global climate change and ability to predict climate over decades to centuries will enable us to develop science-based solutions that will reduce and minimize the impacts of climate change and help us better plan for our Nation's future energy needs.

The Challenge

The BER research program is focused on scientific issues that will greatly improve our understanding of climate change, and greatly impact how energy is produced and how environmental cleanup is managed. Major research efforts include:



Climate modeling

Climate Prediction. Advanced climate models are needed that describe and predict the individual roles of oceans, the atmosphere, ice, and land masses on climate over time. So too, the role of clouds in controlling solar and thermal radiation onto and away from the earth needs to be understood because it is the single largest uncertainty in climate prediction. The Office of Science is also working to understand the impacts of excess carbon dioxide in the atmosphere from human sources, including energy use, on the Earth's climate and ecosystems.

A Cleaner Environment. Microbes have a remarkable capacity to thrive in almost every inhospitable environment imaginable, including those contaminated with metals, radionuclides, and solvents. As we study the molecular details of Earth's own clean-up strategies, the path to developing natural solutions to clean up DOE sites contaminated from years of weapons production seems ever clearer and more promising.

Technology for a Healthier Nation. Developments in imaging technology—increases in sensitivity, ease of use, and patient comfort—have the potential to revolutionize all of medical imaging. Technological wonders, like an artificial retina that will give vision to the blind, are on the horizon.

Medical imaging

A New Biology. Understanding nature's remarkable array of multi-protein molecular machines, each with exquisitely precise and efficient functions and controls, will enable us to use and even redesign these molecular machines to solve challenges in energy, the environment, and national security.

Investment Plan

BER will continue to make investments in the core technologies, research infrastructure, and fundamental science needed to address these exciting challenges. However, the most important scientific advances in this new century will occur at the interfaces between scientific disciplines such as biology, physics, chemistry, and information science.

Of highest priority will be the development of a new research infrastructure needed to understand fundamental biological principles underlying the function and control of biological systems. A combination of novel, state-of-the-art user facilities coupled with large, well-integrated, interdisciplinary research teams will form the basis of a new approach for studying complex biological systems and for using those systems to solve problems in energy, the environment, and national security. Our ability to predict climate on global and regional scales and to develop strategies for the removal of excess carbon dioxide from the atmosphere will depend on the continued development of novel user facilities and a close integration of experimental and computational sciences research. Because of the Office of Science's diverse capabilities across a of range of scientific disciplines, from engineering to chemistry to biology to computing, continued investments in advanced medical technologies will continue to provide the medical community with novel devices and technologies to improve our Nation's health.

The Benefit

Basic biological and environmental research has broad impacts on our health and environment. An ability to predict long-range and regional climate enables effective planning for future needs in energy, agriculture, and land and water use. Biotechnology solutions are possible for DOE energy, environmental, and national security challenges through understanding of complex biological systems and development of computational tools to model and predict their behavior. Understanding global carbon cycles and the associated role and capabilities of microbes can lead to solutions for reducing the impact of excess carbon dioxide on global warming. Biological solutions can be developed to help clean up metals and radionuclides contaminating former DOE weapons sites. Both normal and abnormal health—from human development, to cancer, to brain function—can be understood using radiotracers and advanced imaging instruments. Understanding the biological effects of low doses of radiation can lead to the development of science-based health risk policy to better protect workers and citizens.

Modeling biological pathways

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